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US 6112818 A US 6012523 A
US 5613557 A US 4608739 A

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(54) Abstract Title
An expanding tool for connection between an inner and an outer tubular.

(57) A swedge assembly expands an inner tube 10 that it is located inside an outer tubular 11 so that it sealingly connects. The apparatus A has a mandrel 12, and an attached movable tapered component or wedge 14, that is hydraulically or mechanically operated, and is inserted into the inner tube 10. The leading end 16 of the wedge 14 sits under an inner sleeve 18, which holds one or more seals 20. These seals 20 are located in peripheral grooves 22, and are made from non-metallics, soft metals, composite materials, plastics or other materials suitable for down hole conditions, such as aluminium, elastomers, or PTFE. Each seal 20, has an outer face 24 that engages the inner tubular 10 when it is expanded against the well casing 11 by operation of the wedge 14. If there are irregularities, such as voids or out of roundness, greater expansion of the tubular 10 can occur as the seals 20 respond to the increased loading by re-distributing it.

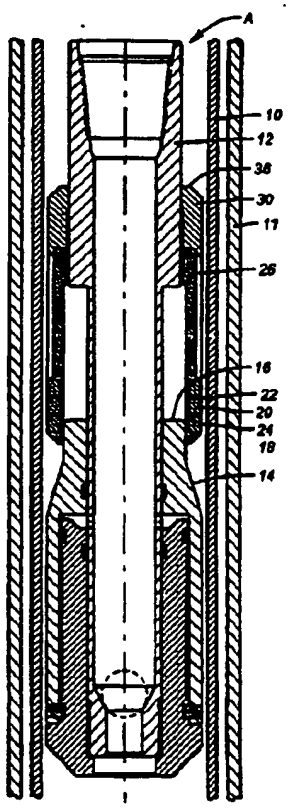

FIG. 1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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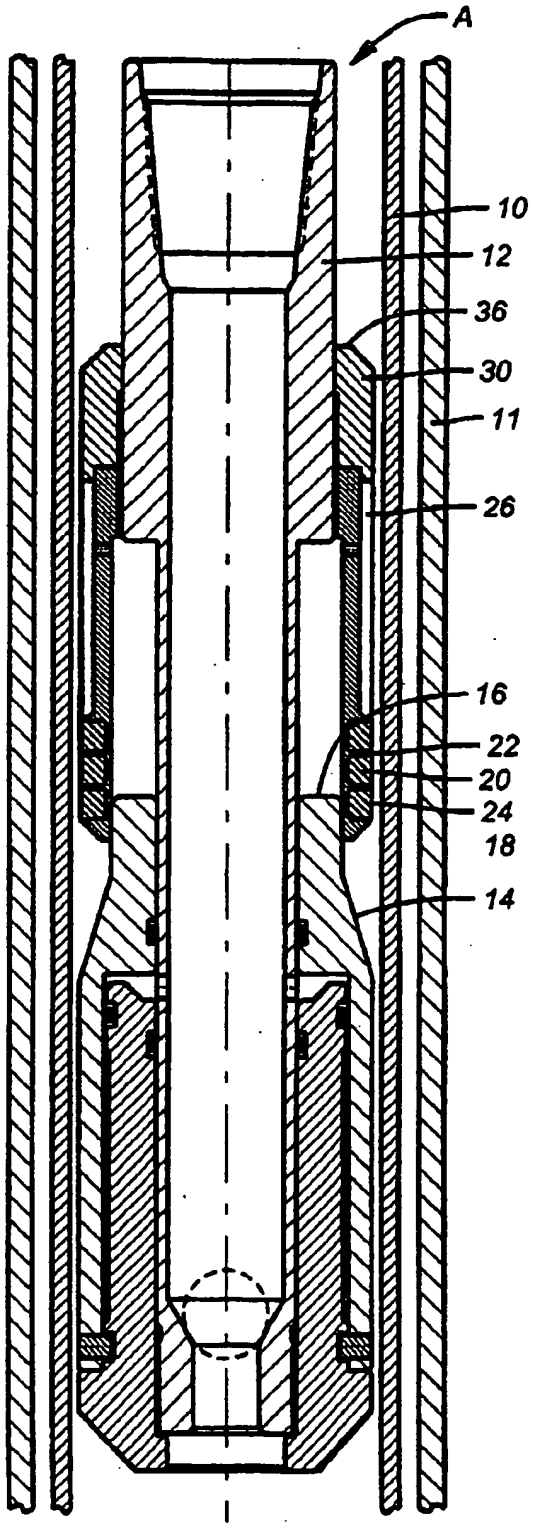

FIG. 1

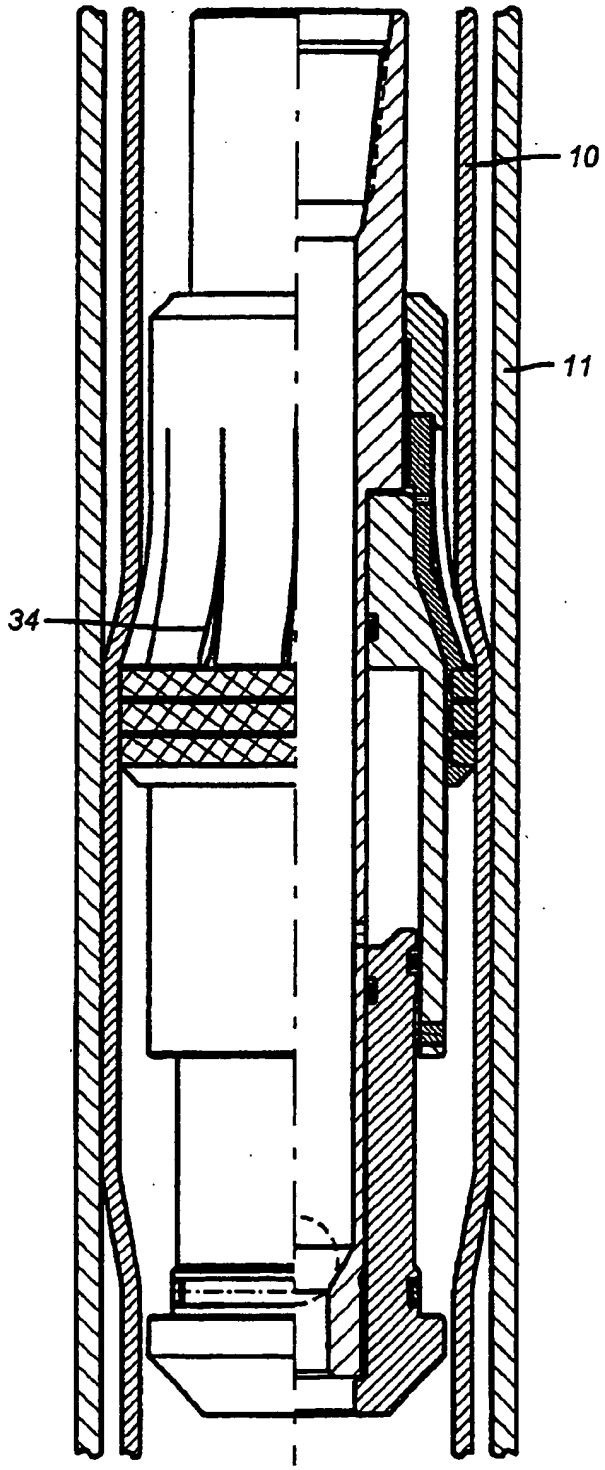

FIG. 2

TITLE: **FLEXIBLE SWEDGE**

INVENTOR: JOHN LINDLEY BAUGH

Field of the Invention

The field of this invention relates to swedges, tubular expansion devices, which can seal an inner pipe to an outer pipe by expansion when the outer pipe is somewhat out of round without need to expand the outer pipe.

Background of the Invention

In the past, techniques have been developed to expand and inner pipe against an outer pipe and such techniques have been applied to attach a liner to casing in a well bore. Because segments of well bore casing could be out of round prior techniques have required a swedge system to have sufficient power to not only expand the inner tubular but also to expand the outer tubular to insure fixation in a full circumferential manner of the inner tubing against the outer tubing. This technique illustrated in U.S. Patent 6,098,717 required the inner tubular to be expanded beyond the yield point by drawing a swedge through it. The inner tubular expanded sufficiently such that the elastic recovery for the inner tubular was less than the elastic recovery for the outer tubular to insure that the tubulars sealed against each other. While this technique was effective, it required significant amount of pulling force or applied horsepower on the swedge.

However, there are applications where the power available to drive the swedge is limited but the circumstances still call for a reliable sealed connection between the inner tubular and the outer tubular in circumstances where the outer tubular could be somewhat out of round. It is therefore an object of the present invention to be able to accommodate situations where the outer

tubular is out of round and expand an inner tubular assembly in such a manner as to fully seal in the portions of the outer tubular which are out of round. It is a further object of the present invention to reduce the required applied force driving the swedge to make a sealed connection between the inner and outer tubulars. Those advantages and others will be readily apparent to those skilled in the art from a review of the description of the preferred embodiment which appears below.

Summary of the Invention

A swedge assembly is disclosed which has the capability of allowing for a sealing connection between an inner tubular and an outer tubular where the outer tubular has significant out of roundness. A resilient segment or segments is disposed on the swedge in contact with the inner tubular to be expanded so as to fill any voids created by out of roundness of the outer tubular. The resilient material may be an elastomer or any pliable metallic or any other material compatible with the applicable well bore conditions.

Brief Description of the Drawing

Figure 1 is a section view of the apparatus in the run in position.

Figure 2 is a section view of the apparatus in the expanded position.

Detailed Description of the Preferred Embodiment

Referring now to Figure 1, the apparatus A is shown inserted into an inner tubular 10 which is in turn in a bigger tubular or casing 11. The apparatus has a mandrel 12 to which is attached a movable tapered component or wedge 14. Wedge 14 can be operated hydraulically with pressurized gas mechanically or by other means.

Referring to Figure 1, it can be seen that the wedge 14 has a leading end 16 which sits under an inner sleeve 18. Inner sleeve 18 holds one or more seals 20. Seals 20 can be made from non-metallics, soft metals, composite materials, plastics, or any other material compatible with down hole well conditions chemically, thermally, and mechanically. Some examples of usable materials would include aluminum, elastomers, and PTFE. The seals 20 are disposed in peripheral grooves such as 22 so that each seal 20 has an outer face 24 which can engage the inner tubular 10 to expand it against the casing 11 as shown on Figure 2.

An outer sleeve 26 is retained to mandrel 12 by thread 30. Outer sleeve 26 has longitudinal splits 34 which are shown on Figure 2 as increasing in size due to the expansion caused by advancing the wedge 14. The splits 34 do not go to the end 36 of the outer sleeve 26 thereby creating a plurality of finger-like segments 38 which expand to engage the inner tubular 10.

In operation, the well bore casing 11 receives a smaller tubular or casing such as 10 to be expanded into contact with it. The wedge 14 is operated to effectively increase the size of the tubular 10 into sealing contact with casing 11. Figure 2 shows the inner sleeve 18 along with the one or more seals 20 after expansion of the tubular 10 against its surrounding casing 11. The advantage of the seal or seals 20 can now readily be appreciated. In the event there are out of roundness conditions in the casing 11 against which the tubular 10 is to be expanded, greater expansion of the tubular 10 can occur to confirm tubular 10 to those irregularities because internally the seal or seals 20 respond to the increased loading due to the out of roundness in the casing 11 so as to allow tubular 10 under the redistributed force through the seal or seals 20 to expand further in the locale of the surrounding casing 11 where it is larger due to out of

roundness. Out of roundness as large as ± .060 inches or more can be accommodated in this manner. In essence, the ability of the seal or seals **20** to distribute the load allows for compensation for out of roundness in the surrounding casing or tubular **11** into which the tubular **10** must be expanded. In essence, the rigid components of the apparatus A accomplish a majority of the necessary expansion of the tubular **10** in the order of 95 percent or more of the requisite expansion to firmly engage the tubular **10** to most of its surrounding outer casing **11**. The presence of the seal or seals **20** allows additional expansion forces to be applied to further expand the tubular **10** into any voids caused by out of roundness in the surrounding tubular. The softness of the seals **20** gives a fluid type property to the seal allowing it to equalize the load circumferentially so that further expansion can take place where there is less resistance due to out of roundness and a circumferential seal of 360° can be obtained as between the tubular **10** and its surrounding casing **11** due to the further expansion facilitated by the seal or seals **20** into any void areas in the surrounding casing.

By using the apparatus A the power requirements are greatly reduced because there is no requirement to appreciably expand the casing **11** to accomplish the seal as was the case in U.S. Patent 6,098,717.

Those skilled in the art will appreciate that the above described preferred embodiment is illustrative of the invention and the scope of the invention is determined by the claims below.

I claim:

1. A method of expanding an inner tubular into a surrounding out of round tubular comprising:

inserting as expansion tool into the inner tubular;

inserting a portion of said inner tubular into said surrounding out of round tubular;

providing a load distributing feature on said expansion tool;

expanding said inner tubular into circumferential contact with said surrounding out of round tubular.

2. The method of claim 1, comprising:

providing a resilient material in said expansion tool as said load distributing feature;

using said resilient material to apply the requisite expansion force to said inner tubular for contact with an out of round segment of said surrounding tubular.

3. The method of claim 2, wherein:

providing at least one circumferential ring of said resilient material on said expansion tool.

4. The method of claim 3, comprising:

locating said material in a peripheral groove.

5. The method of claim 4, comprising:

using rigid portions of said expansion tool for expansion of said inner tubular to at least 95% of its final dimension.

6. The method of claim 5, comprising:

using said resilient material to complete the remaining expansion of said inner tubular into full 360° circumferential contact with said out of round surrounding tubular.

7. The method of claim 1, comprising:

obtaining 360° sealing contact with said out of round surrounding tubular.

8. The method of claim 7, comprising:

avoiding significant expansion of said surrounding tubular.

9. A method of expanding an inner tubular into a surrounding out of round tubular, comprising:

inserting a portion of said inner tubular into said surrounding out of round tubular;

applying an expansion force to said inner tubular;

distributing said expansion force to a portion of said inner tubular that needs to expand further to contact a void caused by out of roundness of said surrounding outer tubular,

minimizing expansion of said out of round tubular by virtue of said distributing of said expansion force.

10. The method of claim 9, comprising:

providing a resilient material in an expansion tool;

inserting said expansion tool into said inner tubular;

using said resilient material to provide the requisite expansion force of said inner tubular for contact with an out of round segment of said surrounding tubular.

11. The methods of claim 10, comprising:

providing at least one circumferential ring of said resilient material on said expansion tool.

12. The method of claim 11, comprising:

locating said resilient material in a peripheral groove.

13. An expansion tool for expanding an inner tubular into a surrounding out of round tubular comprising:

a mandrel;

a movable wedge on said mandrel;

at least one sleeve expandable by said wedge into said inner tubular;

a load distributing device on said sleeve which facilitates incremental expansion of an inner tubular into voids due to out of roundness in the surrounding tubular.

14. The tool of claim 13, wherein:

said load distributing device comprises a resilient material.

15. The tool of claim 14, wherein:

said resilient material forms a ring shape on said sleeve.

16. The tool of claim 15, further comprising:

a plurality of resilient ring shapes on said sleeve.

17. The tool of claim 16, further comprising:

an inner sleeve comprising exposed peripheral grooves in which said resilient ring shapes are disposed.

18. The tool of claim 17, comprising:

an outer sleeve mounted over a portion of said inner sleeve and further comprising at least one longitudinal split that extends for a majority of its length.

19. The tool of claim 18, comprising:

a drive for said wedge powered mechanically, hydraulically, or by pressurized gas.

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Application No: GB 0124248.6
Claims searched:

Examiner: Rebecca Isgrove
Date of search: 31 January 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): E1F : FAC9, FLA

Int Cl (Ed.7): E21B

Other: Online : EPODOC, WPI, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	US 6112818 A	PETROLINE WELLSYSTEMS LTD	-
A	US 6012523 A	PETROLINE WELLSYSTEMS LTD	-
A	US 5613557 A	ATLANTIC RICHFIELD COMPANY (column 2, lines 58 to 64, and figs. 1 and 2)	-
X	US 4608739 A	BIG-TECH MARINE SYSTEMS INC (column 2, line 66 to column 4, line 6; column 11, lines 21 to 35; and column 13, line 52 to column 14, line 68)	1-15

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

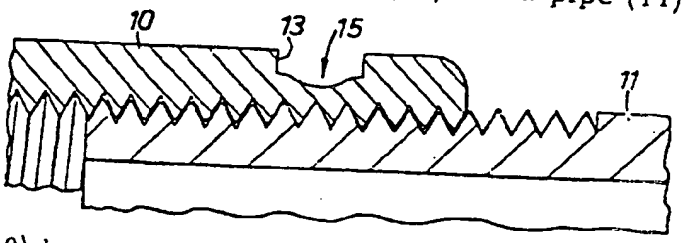
GB 1542647
MAR 1979

CURR/ ★ Q67 C7688B/13 ★GB 1542-847

Fluid-tight pipe coupling - has soft outer connecting sleeve fitting over pipe and reduced thickness region allowing inward deformation to grip pipe

CURRANTE 29.04.75-GB-017678
(28.03.79) F16l-13/14

The pipe coupling has two tubular elements in the form of a tubular coupling sleeve (10) and a pipe (11). The sleeve is of a suitable size to fit over the pipe. The wall of the outer of the two tubular elements (10) has a peripheral annular region (13) of reduced thickness and the element is made of a softer material than the inner (11).



A positive grip to lock the coupling together is achieved by inwardly deforming (15) the region of the outer element.

26.4.76 (6pp1396)

1 542 847

PATENT SPECIFICATION

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(23) Complete Specification filed 26 April 1976

(44) Complete Specification published 28 March 1979

(51) INT. CL.² F16L 13/14

(52) Index at acceptance
F2G 24C 25A

(19)

(54) IMPROVEMENTS IN OR RELATING TO PIPE COUPLINGS

(71) I, THOMAS EUGENE CURRAN of 9, Tyrwhitt Crescent, Roath Park, Cardiff, Glamorgan, a British subject, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to pipe couplings for use in connecting fluid transmitting pipes such as fuel lines, or lines conveying steam, compressed air, gases etc. In such couplings it is important that the joints between the pipes should be fluid or gas-tight at appreciable pressures and since the fuel or other fluid may be inflammable, the coupling should avoid the need for welding operations or the like and must preferably eliminate organic packing materials which might be affected by the fuel; it is also desirable that the coupling should be economical to manufacture and assemble.

Broadly stated in one aspect the invention consists in a pipe coupling combination comprising two tubular elements in the form of a tubular coupling sleeve and a pipe, the sleeve being dimensioned to be placed in or over the end of the pipe, the wall of the outer of the two tubular elements in the coupled assembly being of reduced thickness in an annular region around its periphery, and constructed of a material softer than that of the inner tubular element, such that the wall in the annular region can be deformed inwardly to provide a positive grip between the elements.

Preferably the inward deformation of the annular region also provides a seal between the elements.

The invention also consists in a method of assembling a pipe coupling joint in which one of the tubular elements of the pipe coupling combination, is placed in or over the end of the other tubular element and the wall of the outer tubular element is deformed inwardly to provide a positive grip between the tubular elements. Preferably the outer tubular element is deformed by means of a rotary tool provided with a number of spaced rollers, means for pressing the rollers inwardly against the tubular element and means for rotating the rollers bodily around the axis of the tubular element.

The invention may be performed in various ways and one specific embodiment, with some possible modifications, will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a sectional side elevation through a coupling according to the invention, with two pipe ends located in the coupling, before the final contracting operation,

Figure 2 is a partial sectional elevation on an enlarged scale illustrating the final contraction of the sleeve wall at one end,

Figure 3 is a perspective view of a modified pipe cutter as used for this contraction process,

Figure 4 is a perspective view of one of the rollers which are substituted for the conventional cutter wheels,

Figure 5 is a sectional elevation on an enlarged scale illustrating an alternative form of coupling sleeve according to the invention,

Figures 6 and 7 are further sectional side elevations illustrating further alternatives,

Figure 8 is a sectional side elevation through another form of pipe coupling according to the invention with two pipe ends, before the final contracting operation, and

Figure 9 is a side elevation illustrating the final form of the joint provided by the coupling of Figure 8.

Referring first to Figures 1 and 2, the coupling comprises a cylindrical sleeve 10

of steel or malleable iron or other malleable material formed with an internal screw thread to receive the screw-threaded ends of two pipe sections 11,12. The ends of these two pipes are preferably slightly tapered at the screw-thread portion to assist in forming a tight seal at the joint. Such couplings are well known, but in practice it is found that even when using packing materials leaks occur, particularly at high pressures, and when the fluid line carries penetrating liquids such as petroleum fuel. Moreover, any attempt to tighten one pipe end in a coupling tends to loosen the coupling at the opposite end of the pipe section, or other couplings along the same line. The coupling sleeve 10 is formed with two shallow external peripheral grooves 13, one adjacent each end of the sleeve and extending around the whole periphery. The radial depth of each groove may be approximately half the wall thickness and the width may be approximately twice the depth. After the pipe ends have been screwed into the sleeve a modified hand pipe cutter of the type illustrated in Figure 3 is tightened around the coupling sleeve and forcibly turned to cause the rollers 14 to run around the groove 13 thus deforming the sleeve wall as indicated at 15 in Figure 2 and contracting it inwardly to form a rigid joint and fluid-tight seal with the screw threaded end of each pipe. The grooves 13 provide a location for the rollers 14 and allow the walls of the sleeve in this area to be readily compressible. The operation is repeated at the other end of the coupling sleeve and this forms an excellent mechanical and fluid-tight joint which may be capable of resisting internal pressures of up to 400 p.s.i., or greater, i.e., higher than those obtainable using the normal methods of making such couplings.

The parts of the hand tool are identical with a conventional pipe cutter tool except that the normal cutter wheels are replaced by the rollers 14, as illustrated in Figure 4, with rounded peripheries resembling a car tyre instead of the normal sharp edged cutter wheels. The rollers are mounted on the pivot joint between a series of links 16, attached to a hand lever 17, and provided with a tightening clamp 18.

In the modified coupling illustrated in Figure 5, a shoulder 20 is formed at the end of the sleeve 10, instead of the groove 13 as illustrated in Figure 1. The annular projection portion 21 of reduced thickness is deformed inwardly by a modified pipe cutter in the same manner as described previously, so as to grip the screw-threaded end of the pipe 11.

In the further modification illustrated in Figure 6 the coupling sleeve 10 has no internal screw thread but is formed with a peripheral groove 23 aligned with an annular groove 24 formed near the end of the pipe 25. A line 26 may be marked on the pipe to assist in aligning these grooves 23, 24 before the modified pipe cutter is applied in the same way as described previously to deform the sleeve wall in the region of the groove 23 inwardly into tight sealing engagement with the groove 24.

In the further modification illustrated in Figure 7, the coupling sleeve 10 again has an internal screw thread 31 to fit the external screw thread on the end of the pipe 32. The coupling sleeve also has an annular external groove 33 which is provided with a bevelled flank surface 34 on the side adjacent to the end of the coupling. The final deformation is produced by use of a tool as illustrated previously in Figure 3 but using rollers 35 with bevelled rims 36 instead of the symmetrical tyre-shaped rollers 14 of Figure 4. These bevelled rollers 35 exert a lateral wedging pressure on the flanks of the groove 33 which in some instances facilitates the operation and produces a fluid-type joint with little mechanical effort.

In the further modification illustrated in Figures 8 and 9 the coupling sleeve 40 has an external band 41 midway along its length, of the same external diameter as the two pipe ends 42 with which the coupling is to be used. Each of these pipe ends has an internal annular socket 43 into which the respective end portion 44 of the coupling sleeve is designed to fit. Each of the end portions 44 of the coupling sleeve is of smaller external diameter than the socket 43 and has an external annular rib or ridge 45 which may have a sharp knife edge or may be rounded. In assembling the joint, two pipe ends 42 are fitted over the ends of the coupling as illustrated in Figure 9 and a tool of the type illustrated in Figure 3 is then applied at the zones 46 to force the thin walled portions 47 of the two pipe ends inwardly against the annular ridges 45 on the coupling. This again provides a rigid fluid-type seal without the need for any organic or other sealing or gasket material and without the need for applying heat, as in a welding process.

WHAT I CLAIM IS:-

1. A pipe coupling combination comprising two tubular elements in the form of a tubular coupling sleeve and a pipe, the sleeve being dimensioned to be placed in or over the end of the pipe, the wall of the outer of the two tubular elements in the coupled assembly being of reduced thickness in an annular region around its periphery, and constructed of a material softer than that of the inner tubular element, such that the wall in the annular region can be deformed inwardly to provide a positive grip

between the elements

2. A pipe coupling combination according to claim 1 in which the inward deformation of the annular region also provides a seal between the elements.

3. A pipe coupling combination according to claim 1 or 2, in which the annular region is in the form of one or more external annular grooves.

4. A pipe coupling combination according to claim 3, in which the or each annular groove is formed at a position adjacent an end of the outer tubular element.

5. A pipe coupling combination according to any one of the preceding claims, in which the outer tubular element is internally screw-threaded.

6. A pipe coupling combination according to any one of the preceding claims in which the outer tubular element is formed of steel or malleable iron.

7. A pipe coupling combination according to any one of the preceding claims, in which the outer tubular element is the tubular sleeve.

8. A pipe coupling combination according to any of the preceding claims, in which the inner tubular member has an annular groove on its outer periphery into which the annular region can be deformed inwardly.

9. A pipe coupling combination according to any one of claims 1 to 6 in which the inner tubular member includes a projecting annular rib against which the annular region can be deformed inwardly.

10. A pipe coupling combination according to any of the preceding claims in which the two tubular elements are formed with co-operating screw-threads.

11. A method of assembling a pipe coupling joint in which one of the tubular elements of the pipe coupling combination according to any of the preceding claims, is placed in or over the end of the other tubular element and the wall of the outer tubular element is deformed inwardly to provide a positive grip between the tubular elements.

12. A method according to claim 11, in which the outer tubular element is deformed by means of a rotary tool provided with a number of spaced rollers, means for pressing the rollers inwardly against the tubular element and means for rotating the rollers bodily around the axis of the tubular element.

13. A pipe coupling combination or a coupled pipe assembly, substantially in any of the forms described with reference to the accompanying drawings.

14. A fluid transfer system such as a fluid supply line, including two tubular elements of a pipe coupling combination according to any of claims 1 to 10, joined to form a coupled assembly.

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Agents for the Applicant.

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Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1 542 847 COMPLETE SPECIFICATION
3 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEET 1

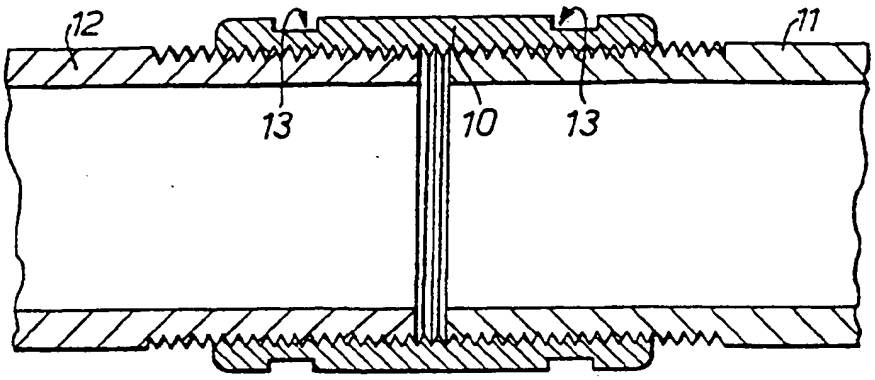

FIG. 1.

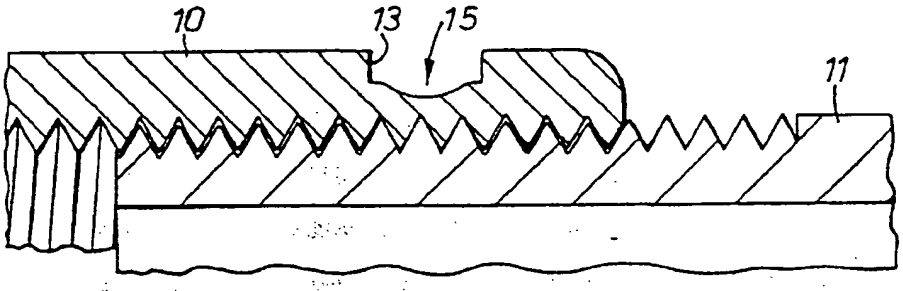

FIG. 2.

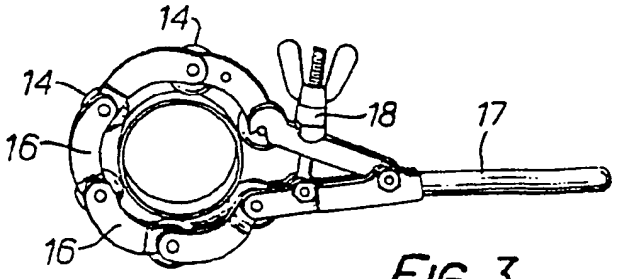

FIG. 3.

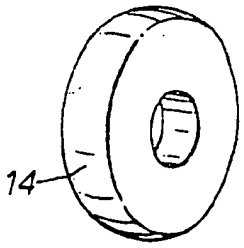

FIG. 4.

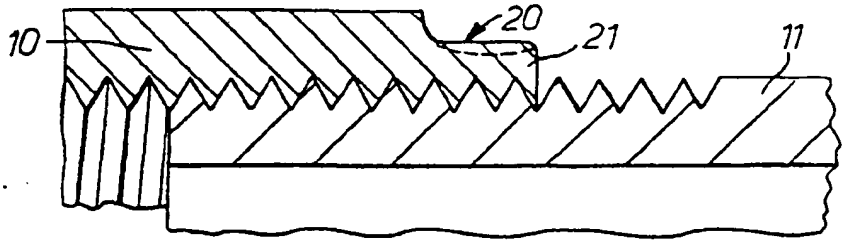

FIG. 5.

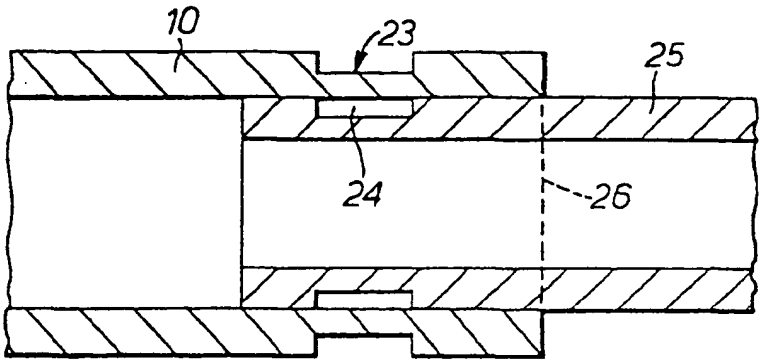

FIG. 6.

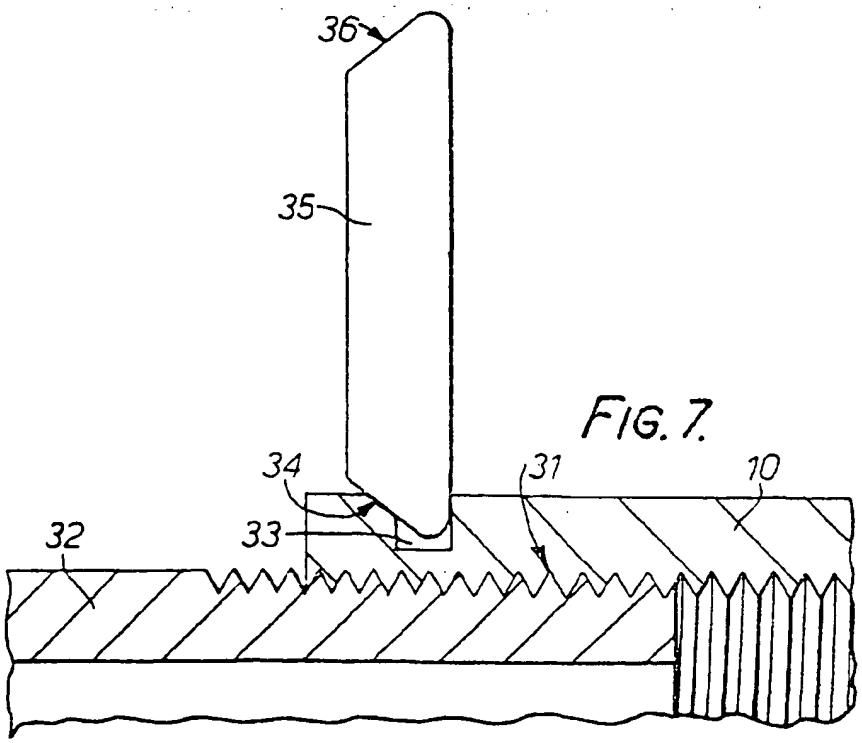

FIG. 7.

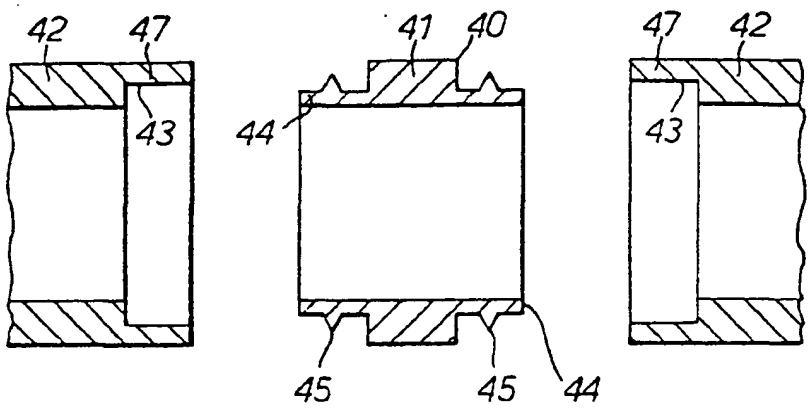

FIG. 8.

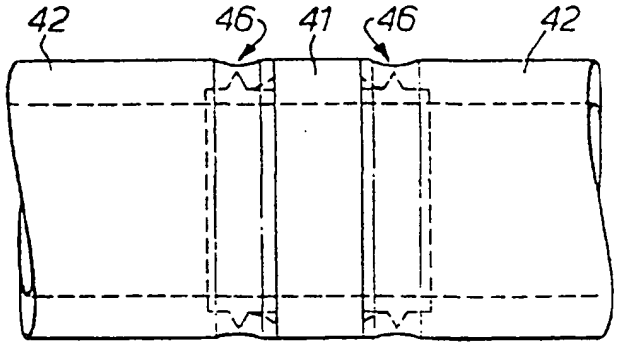

FIG. 9.